Brüel & Kjær
Copenhagen

ELECTRICAL
MEASURING INSTRUMENTS

Deviation Bridge Type 1503-1504-1505 and 1506

The Deviation Bridges Type 1503, 1504, 1505, and 1506 are designed to accurately and quickly present a comparison with or a percentage deviation from a selected standard impedance. Wherever repetitive bridge type measurements are required, these bridges cut the measuring time to a minimum. For example production testing is reduced to the simple operation of placing the product or component to be checked into a jig to obtain the best possible terminal contact, and instantly reading from the large illuminated meter scale its deviation from the standard, both in terms at impedance and phase angle. The Deviation Bridges incorporate the following outstanding features:—

1. Extremely rapid production testing species of up to 3600 operations per hour.
2. A large six-inch illuminated meter with easily viewed pointer giving low operator fatigue.
3. The percentage impedance deviation of the test component from the standard and the phase angle difference in radians, are read with a comparison accuracy of o.03 %.
4. Interchangeable meter scales permit the use of a single scale for each of the sensitivity ranges in order to lessen the possibilty of confusion. Two blank scales are provided so simple limit tolerance may be marked.
5. Range calibrations and zero adjustments to built-in standards are readily performed.
6. The high stability of the zero setting allows adjustment-free operation throughout a day.

Fig. 1. Photo of one of the Deviation Bridges.

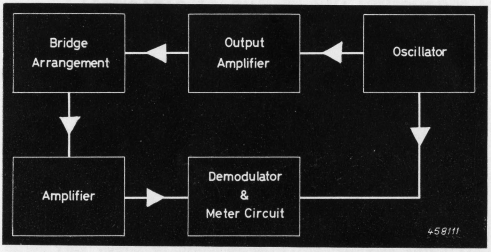

Fig. 2. Block diagram of the Deviation Bridges.

DESCRIPTION:

The four types of deviation bridges are similar to each other except for the frequency and the measuring ranges, see specification on page 4.

Each instrument consists of a bridge arrangement with two fixed resistors and two sets of input terminals, one for an external standard, and one for the component to be tested. The bridge voltage is supplied from a built-in generator.

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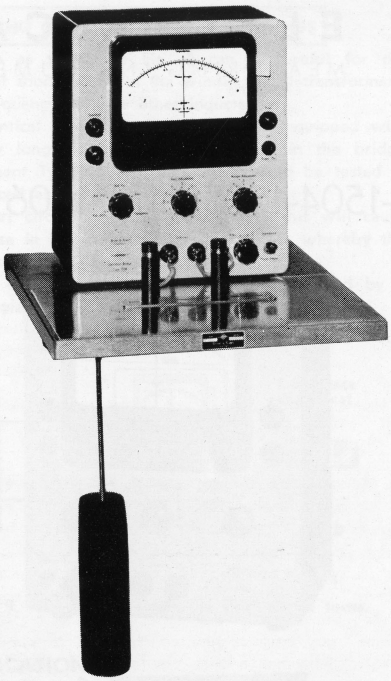

Fig. 3. Deviation Bridge mounted on the Test Jig Type 3902 for production line testing.

When the value of the component being tested deviates from that of the Standard a diagonal voltage is developed in the bridge. This voltage is fed via a two stage amplifier to a phase sensitive demodulator and measured by means of a moving coil, centre zero indicating meter with large interchangeable scales. The calibrated meter scales show directly the amount of positive or negative deviation in percent and the positive or negative phase angle in radians $\times 10^{-2}$ between the standard and the measured object.

Test Jig Type 3902.

The Test Jig Type 3902 is designed for use with the Deviation Bridges to facilitate the ease of and speed up the operation of production testing of components. The Jig consists of:

1. A mahogany mounting table for the Deviation Bridge.
2. Two spring-loaded binding posts. The binding posts apply optimum pressure to the leads when inserted and their position can be adjusted according to the component size. The constant position of the binding post leads avoids changes in capacity and assure a stable test set-up.
3. A lever arm which operates the binding posts, positioned for knee operation.
4. Ground shielding plates to prevent hum and magnetic field interference.

Box for Standards ZR 1702.

For convenience it is recommended that the standard-impedances in use are placed in the Box for Standards ZR 1702. On the circular base is fixed two pins at the spacing corresponding to the bridge terminals of the Deviation Bridge allowing direct connection. Fig. 4 shows the Box for Standards.

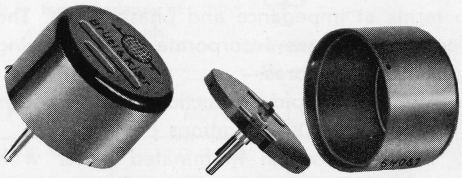

Fig. 4. Photo of the ZR 1702 Box for Standards.

EXAMPLES OF APPLICATION

Although the basic applications of the Deviation Bridges are similar, certain ranges of test component values exist in which it is convenient to use one particular type of Bridge. In the examples given in the following this is taken into account.

PRODUCTION LINE TESTING OF CAPACITORS

The Deviation Bridge Type 1503 is suitable for production line testing of capacitors with values ranging from 500 $\mu\mu$F to 5000 μF and Fig. 3 shows a typical measuring stand which can be used for this purpose in factories or stock-rooms. A standard capacitor should be connected to the upper left terminals of the Bridge and the unknown capacitor placed between the two binding posts of the Test Jig Type 3902 which is then operated by means of the lever seen to the left.

With this arrangement it is possible to check very large quantities of capacitors in a minimum of time.

LABORATORY MEASUREMENTS OF RESISTORS

In laboratories where resistors are frequently measured, it will be practical to have a Deviation Bridge Type 1504 which is permanently connected to a standard resistance box as indicated in Fig. 5. When the "Unknown" is connected to the bridge terminal the standard resistor should be varied until the bridge is balanced, and the value of the unknown resistor may then be read off the standard resistance box. This form of resistance measurement is much quicker in practice than adjusting a Wheatstone Bridge as the meter of Type 1504 responds much quicker than the usual light spot galvanometers. However, when large wirewound resistors are tested the measuring frequency of Type 1504 might cause a too high phase angle deviation between the standard and unknown. In such cases it is advisable to substitute Type 1504 by Type 1503.

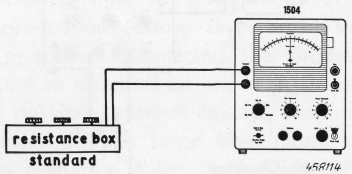

Fig. 5. Deviation Bridge used with standard resistance box for resistance measurements in laboratories.

BALANCE OF GANGED POTENTIOMETERS

For the adjustment of ganged potentiometers or variable resistors the set-up shown in Fig. 6 will be practical. The two end-terminals of the variable resistors are connected to the upper left and lower right terminals of the Bridge, while the moveable arms are joined together and connected to one of the two remaining terminals. The balance expressed in % deviation may then be checked for all positions of the moveable arm. Suitable Bridge Type: 1503 and 1504.

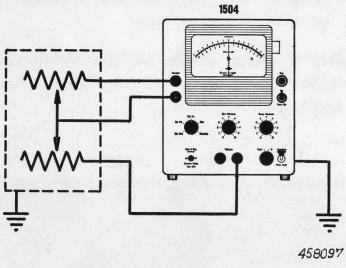

Fig. 6. Checking the balance of ganged potentiometers.

CHECKING THE REMANENCE OF PERMANENT MAGNETS FOR T.V.-SETS

The remanence of permanent magnets used for the adjustment of the horizontal linearity in TV sets may be checked by means of the Bridge Type 1505 which with its measuring frequency of 10 kc/s is specially well suited for this purpose.

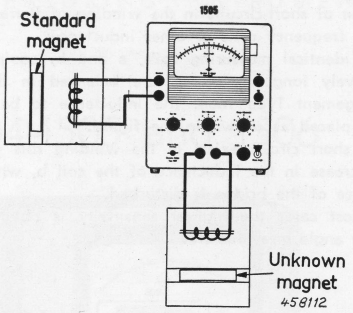

Fig. 7. Set-up for testing remanence of permanent magnets for TV-deflection circuits.

As shown in Fig. 7 two identical coils are connected to the terminals of the Bridge. A magnet with the minimum remanence required for the TV set is placed beside the coil connected to the "Standard" terminals. The magnet to be checked is then placed beside the coil at the "Unknown" terminals in a relative position which equals that of the "Standard". A positive deflection on the meter means "go" because the remanence of the unknown is greater than that of the standard—and consequently,—a negative deflection means "no go".

DIRECT-READING MEASUREMENTS OF CAPACITORS

The Deviation Bridges may also be used as direct-reading instruments for measurements on capacitors. Two equal capacitors of an exact known capacity are connected across the "Standard" and "Unknown" terminals, as shown in Fig. 8. The unknown capacitors are then measured as a percentage increase of the fixed known value. By choosing the fixed capacitors as pure powers of 10 the direct reading will be simplified. To make the adjustment easier, it will be practical to have part of the capacitance on "Standard" placed as a small trimmer capacitor. The unknown capacitor should then be connected to the two open terminals seen in the figure.

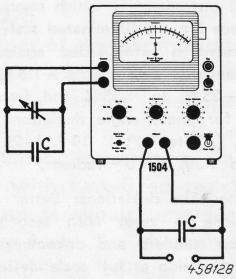

Fig. 8. Direct reading measurements of capacity values.

CHECKING COILS FOR SHORTED WINDINGS

A set-up as shown in Fig. 9 can be useful for detection of short-circuits in the winding of IF-transformers, radio frequency coils or other inductances.

Two identical measuring coils, a and b, equipped with relatively long iron cores, are balanced in the bridge arrangement Type 1506. The inductance to be tested is then placed as shown in the figure.

If a short circuit exists in the winding this will cause a decrease in the inductance of the coil b, whereby the balance of the bridge is disturbed.

In most cases the highest sensitivity is obtained by a phase angle measurement.

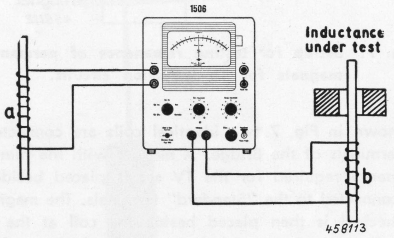

Fig. 9. Checking of coils for short-circuit turns.

IMPEDANCE OF MAGNETIC HEADS FOR TAPE RECORDERS

By means of the Deviation Bridge Type 1505 measurements of the impedance of heads for magnetic tape recorders are readily carried out. Prior to measuring, however, attention must be paid to the operational voltage of the head under test. As the bridge voltages for Type 1505 is approximately 3 volts, o.6 volts, and o.15 volts for the different measuring ranges (1 %, 5 %, and 20 %), it is normally necessary to use matching transformers as shown in Fig. 10. The two transformers (T_1 and T_2) must be absolutely identical in order not to increase the deviation to be measured.

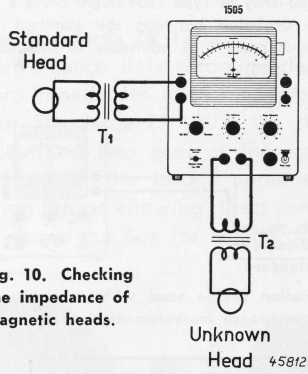

Fig. 10. Checking the impedance of magnetic heads.

SPECIFICATION

Ranges of Test Components:

Type	1503	1504	1505	1506
Resistance:	1 Ω–30 MΩ	10 Ω–10 MΩ	10 Ω–1 MΩ	10 Ω–50 kΩ
Capacitance:	500 pF–5ooo μF	50 pF–10 μF	30 pF–1 μF	20 pF–o.1 μF
Inductance:	2 mH–2ooo H	2 mH–100 H	o.2 mH–2 H	20 μH–20 mH
Measuring Frequency:	100 c/s	1 kc/s	10 kc/s	100 kc/s

Bridge Voltage:	**1503**	**1504-5-6**
"Ref. 1 %"	Approx. 1.5 V	Approx. 3 V
"Ref. 5 %"	» o.3 V	» o.6 V
"Ref. 20 %"	» o.08 V	» o.15 V
"Ref. 20 % on 100 % Range"	» o.04 V	

Meter:
Large moving coil instrument in which removeable scales can be inserted (see Fig. 1). Illuminated scale with centre zero. The instrument is safeguarded against overload. Ranges for impedance deviations from −1.5 % to +1.5 %, −7 % to +8 %, −25 % to +35 % and from −50 % to +100 %. Ranges for phase angle deviations from (−1.5 to +1.5) × 10^{-2}, (−7 to +7) × 10^{-2}, (−25 to +25) × 10^{-2}, and (−80 to +80) × 10^{-2} radians.

Accuracy for impedance deviations: Better than o.03 % for deviations close to zero. With zero phase angle difference between standard and unknown; better than 3 % of indicated deviation at full scale deflection.

Stability: The zero point is independent of the line voltage. Deflections from the zero point will change 3 % for a 10 % variation of line voltage.

Impedance - Phase Angle Switch: A micro-switch is included to allow rapid switching from impedance to phase angle measurements.

Tubes:

1503	1504	1505	1506
2 × 6AU6 (EF94)	3 × 6AU6	3 × 6AU6	2 × 6AU6
12AT7 (ECC81)			12AU7 (ECC82)
6AQ5 (EL90)	6AQ5	6AQ5	6AQ5
6X4 (EZ90)	6X4	6X4	6X4
OA2 (150C2)	OA2	OA2	OA2

Power Supply.
115 – 127 – 150 – 220 – 240 volts AC. 40–400 c/s. 40 watts.

Dimensions: Height: 33 cm (13"), Width: 28 cm (11"), Depth: 20.5 cm (8").

Weight: 1504-5-6 10 kg (22 lbs.), 1503: 11 kg (24 lbs.).

Printed in Copenhagen, Denmark October 1961